CONTENTS:

2 Editor’s Comments
M. A. Berawi, Ph.D.

4 Pedagogy of Teaching Value Management in an Undergraduate Surveying Program
Ann T.W. Yu, Ph.D. and Geoffrey Q.P. Shen, Ph.D., MIVM, MHKIVM, VMF, CVS

13 The VE Workshop at McGill University: Benefits for Students and Industry
Vince Thomson

19 Value Added Strategies to Sustain a Successful Value Improvement Program
John L. Robinson, PE, CVS-Life

26 The Integration of the Japanese Tear-down Method with Design for Assembly and Value Engineering
James A. Rains, Jr., CVS-Life, FSAVE, PVM and Yoshihiko Sato, CVS-Life, FSAVE
Managing Education and Practical Workshops for Value Management/Value Engineering Program

Welcome to the Value World.

First of all, I would like to solicit your valuable contribution to continually promote our journal as a key journal for the development and discussion on both academic and practical knowledge relating to “value”.

This fall’s themes on education and practical workshops have been chosen due to their vital roles for the value engineering/value management community growth and professional development. Education and training workshops have been argued as critical factors that contribute to the success of the future of our profession. The success of a profession is dependent on its members being able to adapt to the changing environment and updating the knowledge and skills by exploring new ideas and methods. Rapidly changing environment requires that we possess the knowledge, skills and abilities needed to cope with new processes, techniques and requirements. Thus a systematic process of evaluating our education and workshop system-related achievements, strengths as well as determining ways to improve performance is necessary for our professional development program. This edition illustrates how education and workshop system for value engineering/value management program is done in a variety of ways by educators and practitioners from different areas in different countries.

There are several questions that will be discussed on this fall edition including: what are the assessments that we do in our education and workshop system that would lead us to believe that the processes are successful? how can we promote and expand the use of value engineering/value management methods? given that they are the coin of the realm, how can we sustain our successful value engineering/value management program? what are the lessons learnt that can be drawn? are there modifications required of the current process?

Education and Workshop System

This issue of Value World presents papers from the 2008 Annual SAVE Conference in Nevada and the Value World journal submission on value engineering/value management education and workshop system. This edition explores how the education and workshop system of value engineering/value management has been developed, practiced and integrated in two ways—theoretical knowledge at the one end, and practical application at the other. I present you four papers selected to stimulate a debate and to explore our education and workshop system for value engineering/value management program.

The first two papers examine the methods and activities of providing the value engineering/value management module at the university level in Hong Kong and Canada. Dr. Ann Yu and Professor Dr. Geoffrey Shen examine why there is a significant value to both academic researchers and construction professionals for improving our comprehension of the pedagogy of teaching value management to enhance competitiveness of the professional services in the construction industry.

Furthermore Professor Dr. Vince Thompson determines how a university provides value engineering workshop for the interaction of students and industry. The mutual exposure raises the engineering professionalism of the students, provides solutions to problems for companies, and contributes to the education process. On other hand, companies that have participated in the workshop, obtaining significant value enhancement to product design, manufacturing processes and services, as well as learning the value engineering methodology.

The third paper written by John L. Robinson, PE, CVS-Life is taken from the practice of a value engineering workshop that focuses on value added strategies to sustain a successful value improvement program. Based on his experiences of presenting in-service value engineering studies on public and private capital projects, he discusses on the baseline and characteristics for what constitutes a successful Value Program. He argues that to sustain or build a successful Value Engineering Program, a value culture must first be established in an organization. He also examines how actions can result in unintended consequences that contribute to the downfall of a successful value program.

The fourth paper, written by James A. Rains, Jr., CVS-Life, FSAVE, PVM and Yoshihiko Sato, CVS-Life, FSAVE, J-MCMC describes the integration of tear-down/design for assembly (DFA) and value engineering method in value engineering workshop process. The value analysis (VA) tear-down as a method of comparative analysis of product/project has been described into various elements including dynamic, cost,
I hope this edition of Value World brings new insights in the way we conduct our education and workshop for value engineering/value management program. I can be contacted at maberawi@um.edu.my and I will gladly accept and respond to any comment and enquiry you may have on the direction and content of Value World. Your feedback is important to the success of our journal as it will guide its future development.

With warmest regards from editorial desk,

Dr. M.A. Berawi
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Celebrate 50 Years of Value at SAVE
International’s 2009 Annual Conference

Join SAVE International in the gala celebration of its 50th anniversary. The society’s 2009 annual conference will take place June 29 - July 2 at the Detroit Marriott at Renaissance Center in Detroit, Michigan, USA.

Present Your Technical Paper

Continue the scholarly discussion, stimulate debate, and build professional credentials as a technical program speaker. SAVE International will accept abstracts for papers and presentations through October 15, 2008. Submit your abstract via the society’s website (www.value-eng.org).

Teach a Workshop

Do you have expertise to pass along? A new technique or application to teach? Submit your proposal for a pre-conference workshop and share in the profit of continuing professional education. SAVE is accepting workshop proposals through October 15, 2008. Submit your proposal via the society’s website (www.value-eng.org).

Recognize Outstanding VM Contributions

Do you know someone who has gone to outstanding efforts in VM outreach? Someone who has used the value methodology with incredible results—and an ecstatic client? Someone who deserve recognition for dedication to the society and to the value methodology? Nominate someone—even if that someone is yourself—for SAVE honors and awards. SAVE is accepting nominations through February 1, 2008. Send nomination packages to the society business office at info@value-eng.org.

Show Your Support

Support SAVE International and be involved in the conference by way of purchasing an exhibit space and sponsorship. For around the cost of a conference registration, you can add an exhibit space. For a sponsorship of $1,000 or more, you will receive advertising benefits and an exhibit space. Be recognized as a VM leader and generous supporter of the professional association that works for you. Exhibit and sponsorship forms are available online (www.value-eng.org).
Pedagogy of Teaching Value Management in An Undergraduate Surveying Program

Ann T.W. Yu, Ph.D. and Geoffrey Q.P. Shen, Ph.D., MIVM, MHKIVM, VMF, CVS

Abstract

As Value Management (VM) is a valuable tool for developing multi-disciplinary team work in the development process of a construction project, the subject of value management is being offered by the Department of Building and Real Estate of the Hong Kong Polytechnic University to students who are taking the BSc (Hons) in Surveying Degree Program. Under the new outcome-based curriculum, the methods and activities of VM workshops and the lessons learned are reviewed and described in this paper by answering the questions of “what are the institutional, programme and subject learning outcomes,” “what should students learn in the subject of VM,” and “how VM should be learned, taught and assessed.” The results of questionnaire survey of the students’ feedback on VM workshops for the past two years are also presented and discussed. The students believed that value management workshops are essential in the curriculum and the approach for conducting the workshops has been assured with confidence. They expressed that it was a valuable experience to participate in the VM workshop which enabled them to have a better understanding of the subject although some improvement is recommended for future organization and management of workshops based on the lessons learnt in these two academic years.

Keywords

Value management, workshop, teaching, pedagogy

Introduction

Pedagogy, as described in some of the educational literature, is sometimes used as a synonym for teaching. In this sense, pedagogy is seen as a catch-all term for such things as teaching procedures, teaching practice and instruction (Loughran, 2006). However, pedagogy can be seen to encompass much more than simply teaching (van Manen, 1999). Pedagogy is the art and science of educating students and as van Manen makes clear, focusing on the relationship between learning and teaching such that one does not exist as separate and distinct from the other is crucial to such education. Watkins and Mortimore (1999) define pedagogy as “any conscious activity designed by one person to enhance learning in another”. In order to address the effectiveness of teaching and learning, teaching methods should be aligned with needs of the learners and with the desired learning outcomes. Some pedagogical principles for teachers can be formulated, though only at a very general level. From the literature searches undertaken by various authors it appears to be beneficial if teachers (Ireson et al., 1999):

- are clear about their aims and share them with learners
- plan, organize and manage their teaching effectively
- try to formulate the highest expectations about the potential capabilities of learners and their level of progress
- endeavour to provide positive formative feedback to all their students
- recognize the distinctiveness of individual learners within a general context of inclusivity
- provide learning tasks which will challenge and interest and which are aligned to appropriate assessment procedures
- seek to relate academic learning to other forms of learning and promote ‘boundary crossing’ skills
- make explicit the rules and, at times the hidden conventions of all learning institutions so that all learners become aware of ways in which they will be judged
- include an understanding of metacognition in their objectives so that all learners can benefit from this knowledge and – as they advance through their learning careers, take increasing responsibility for their own learning
- motivate and enthuse learners.

Value Management is a structured, organized team approach to identifying the functions of a project, product, or service with recognized techniques and providing the necessary functions to meet the required performance at the lowest overall cost (SAVE International, 2001). It is highly concerned with the surveying consultants who are stakeholders of a multi-discipline team in a construction projects. Thus, the subject of Value Management has been offered by the Department of Building and Real Estate of the Hong Kong Polytechnic Uni-
versity to students who are taking the BSc (Hons) in Surveying Degree Program, upon graduation, they will be building surveyors, quantity surveyors and general practice/estate surveyors in the construction industry. This paper describes the pedagogy of teaching VM using workshop approach for these students in the past two academic years, 2006-07 and 2007-08. This is of significant value to both academic researchers and construction professionals for improving their comprehension of the pedagogy of teaching value management to enhance competitiveness of the professional services in the construction industry.

The curriculum contents, pedagogy, and assessment methods of the subject must be relevant, competent, and meaningful (Wlodkowshi, 1999), and in line with following and teaching and learning strategies of the university:

1) All-round development of students beyond the professional context including language or interpersonal enhancement, culture promotion and ethics.
2) Student-centered learning strategies, for example, problem-based learning (PBL), project-based learning, peer tutoring, peer assessment, etc.
3) A caring and supportive learning environment by the mechanisms for access to teaching staff, mentors, and head of departments;
4) The importance of good teaching and professional development of teaching staff supported by the Learning and Teaching Resources Centre in the University;
5) Using information and communication technology (e.g. web-based learning) as a tool to enhance learning and teaching; and
6) Partnership with professionals and the community. For example, professionals are invited as guest lecturers and feedback is solicited from employers of the industry.

What are the institutional, programme and subject learning outcomes?

The intended learning outcomes for PolyU graduates are categorized in three different levels: institution, programme and subject.

**Intended Learning Outcomes for PolyU Graduates**

PolyU has pledged itself to developing students with professional competence and attributes necessary for the knowledge-based society in the 21st century. This commitment has been stated in a number of important official documents (emphases added):

“To become a preferred university offering preferred pro-

grammes and producing preferred graduates”

PolyU’s Vision Statement in the Strategic Plan for 2001/02 - 2007/08

“To enhance the all-round development of students, particularly in the areas of global outlook, critical and creative thinking, social and national responsibilities, cultural appreciation, lifelong learning, biliteracy and trilingualism, entrepreneurship and leadership”

Strategic Objective 1 stated in the Strategic Plan for 2001/02 - 2007/08

“To provide high value-added education, with a balanced approach leading to the development of all-round students with professional competence”

Role statement of PolyU finalized by UGC in 2003

**Programme outcomes**

The programme aim of BSc (Hons) in Surveying is to prepare students with fundamental knowledge and skills in the inter-disciplinary professions of land, property and construction for their immediate employability and lifelong learning. The programme underpins surveying studies with the disciplines of economics, law, management and technology. Graduates will enter the professionals of building surveying, quantity surveying or general practice surveying as graduate trainees but with full potentials to readily become full-fledged professional surveyors and finally take leading and strategic roles in the profession and business of land, property and construction and make contributions to the community through their chosen professional services.

**Category A Professional/academic knowledge and skills**

Upon successful completion of the programme, the students and expected to attain the following abilities:-

1) To comprehend and identify issue and problems concerning land, property and construction at project, corporate and industry level.
2) To comprehend and identify issues and problems concerning land, property and construction at marco social-economic and political level.
3) To advise clients through rendering surveying services.
4) To identify, formulate and solve problems related to the surveying profession and real estate industry.
5) To analyze and interpret data of the industry.
6) To formulate and implement strategies, policies and solutions for sustainable development and construction.

**Category B Attributes for all-roundedness**

Upon successful completion of the programme, the students are expected to possess:-

1) To comprehend and identify issue and problems concerning land, property and construction at project, corporate and industry level.
2) To comprehend and identify issues and problems concerning land, property and construction at marco social-economic and political level.
3) To advise clients through rendering surveying services.
4) To identify, formulate and solve problems related to the surveying profession and real estate industry.
5) To analyze and interpret data of the industry.
6) To formulate and implement strategies, policies and solutions for sustainable development and construction.
Learning outcomes of the subject

Under the new outcome based curriculum, the learning outcomes of the Value Management subject are:

1) Have an understanding of the value management methodology
2) Organise and manage value management workshops in different phrases of a project life cycle
3) Conduct function analysis and life-cycle costing for a project or a part of a project
4) Exercise practical creativity skills to work with a team of stakeholders to arrive at innovative solutions for construction projects
5) Ensure value for money for projects by applying value management tools in business situation or technical situations of a construction company.

What Should Students Learn?

Focusing on high status knowledge, high value skills, and real-world applications and according to the goals and objectives of the curriculum, textbook, reference readings, PowerPoint Slides, and videos are produced or chosen for the learning and teaching activities. Before the commencement of the sessions, the learning outcomes of the subjects, topics to be covered, assessment procedure, academic policy are distributed to students providing them with learning objectives, curriculum content and assessment methods. Before the commencement of the session, a syllabus and teaching schedule of the subject are distributed to students providing them with the learning objectives, curriculum content, assessment procedure, available resources, and planning and self-management skills to initiate self-controlled study (Parker and Harris, 2002). The learning, teaching and assessment activities comprise 30 to 36 hours of lectures and tutorials, 46 hours of independent study reading self study material, one multiple choice test and 3 to 6 hour VM workshop, and one 2-hour written examination.

Brief Syllabus Content:

- Notion of value: value, function and cost
- Value management basics: historical development; project selection (types, values, and timing); alternative workshop approaches (e.g. the 40-hour job plan, the Charette, the VM audit, and the contractor's change
- Value management methodology: VM job plan (information, function analysis, creativity, evaluation, development, proposal); group dynamics, facilitation, creativity, and problem solving skills
- Timing of VM study, managing VM workshop, selection of projects for VM study, critical success factors of VM workshop
- Life cycle costing for construction projects
- Comparison of value management and traditional cost management techniques
- Benefits and limitations of VM, problems and barriers of VM study
- Case studies of the practice of value management in Hong Kong and overseas

How Should VM Be Learned, Taught, and Assessed?

How do students learn? Neuroscientists believe that students’ learning will be increased by receiving a lot of stimuli and challenges in lessons. Educational psychologists believe that learning occurs under the models of behaviorism, cognitive constructivism, social constructivism, or the combination of the aforementioned ones to produce optimal learning and teaching outcomes (Joyce et al., 2002; Roblyer, 2006). The combination or blended model is adopted in modern practice in which both teaching-oriented and learning oriented instructional activities are designed to comply with the objectives. Teaching-oriented activities include the design and planning of teaching and learning activities, teaching schedules and materials, criterion-referenced formative and summative tests and facilities management for the session. Learning-oriented activities include implementation of the instructional activities, monitoring and improving students’ mastery of learning, obtaining feedback from all parties involved, and evaluation and continual improvement of the curriculum (Lam, 2008). These activities are demonstrated below.

When selecting any teaching and learning method it is obviously important to ensure that the method will enable the students to achieve what are intended as learning outcomes. There are different kinds of methods available. Interactive lecture is characterised by interactions, both teacher with students and students with their peers. It breaks the information
presentation into several sessions so that frequent learning activities can take place to foster deeper processing of content. The key is to activate thinking and encourage participation. It is effective in building up subject knowledge. A diverse range of activities, such as brainstorming, case study, open-end discussion can be integrated into the lecture.

Before attending the VM lecture, students are required to read the particular chapter(s) of the textbook or watch the video record to prepare themselves for the scheduled topics. In the first 10 min of the lecture, the subject lecturer describes the learning outcomes of the topic(s) and invites students to ask questions on the outline of the topic. In the first half of the lecture, the subject lecturer presents by PowerPoint the important concepts and theories of the topics which students may overlook or not understand in the textbook. Video record is also used to supplement the lecture and the subject lecturer incorporate comments to the video from the time to time so as to get students’ attention. At the same time, the main points and key concepts of the topics are to be covered in the presentation followed by a summary. Students are encouraged to raise questions during and after the presentation. Tutorial sheets are then distributed to the students for carrying out further readings and prepare for the discussion and presentation in the tutorial session in the following week.

The tutorial is a session that is additional or supplementary to the lecture. It is intended for further exploration of concepts, theories, principles and inquiries arising from the lectures so as to help students to develop deep understanding of the topics and skills and to apply knowledge to solve problems. The tutorial, used as a discussion platform can be administered in many formats such as buzz groups, pyramids, debates, fishbowls, etc. During tutorial sessions, students are required to discuss and present the tutorial questions which have been distributed in previous week. Students are asked to form small groups of five and carry out discussion on assigned questions. Attempts are made to make sure that the questions/problems for each group are challenging, meaningful, and can only be done with group effort. Students are encouraged to recall their knowledge, develop their ideas and report back to the whole class under minimum guidelines or hints from the subject lecturer. The subject lecturer would ask short questions from real-life situations to individual for deep thinking to ensure that everyone contributes to the session and that knowledge is constructed by the students. In the last 15 min, the subject lecture provides her answers and comments on the opinions, strength and weaknesses of the groups, and draw conclusions by referring to the concepts and theories that are taught in the first session of last lecture. After the lecture, PowerPoint slides and lecture notes will be placed in the WebCT system of the University to facilitate independent learning among the students.

During the session, formative and continuous assessments are frequently organized in the form of oral presentation, quiz, phase test by which the subject lecturer communicates expectations and standard of learning performance to the students. A revision lesson may be needed of students’ learning outcomes are below expectation A portfolio of assessment resulting from students; performance is recorded. At the end of the semester, a revision of all the topics is given to reinforce students’ understanding so that they have confidence of passing the final examination. Summative assessment on the form of a written examination is then organized to assess the effect of the completed program and compare the performance of students. The learning outcomes are graded by the criterion-referenced levels of the Structure of the Observed Learning Outcome (SOLO) Taxonomy published in EDC (2005) and Biggs and Collis (1982). Teacher performance is assessed by the overall student performance, student feedback questionnaire (SFQ), teaching portfolio, in class peer evaluation (IPE) by EDC colleagues or academic advisor, student-staff consultative meeting, and program committed meeting.

Hands-on Experience in Value Management Workshops

In order to achieve the learning outcomes, the subject lecturer and tutor determined to conduct a VM workshop with the students towards the end of the semester after completion of all lectures. These VM workshops have been carried out with the students since the academic year 2006-07. The students were instructed to organize and participate in a VM workshop with a brief describing the requirements of the workshop and scenario of a real life project one month before the VM workshop. The scenario of the Stonecutter Bridge project is summarized in Figure 1. The workshop proposal and agenda were also provided to the students (see Table 1, next page).

During the pre-workshop phase, the students were asked to identify the participants of the workshop and assign each of them a role in the project. They acted on behalf of the organization and searched information regarding their role and information of the project. Presenters in the information phase were nominated and they prepared the PowerPoint slides for the presentation. The facilitator prepared the agenda of the workshop and distributed to the students for advance information. A pre-workshop meeting was held so that the students could raise their concerns and queries and guidance was provided for running the workshop.

The students were led by facilitators into the job plan of the VM methodology i.e. information, function analysis, creativity, evaluation and development phase of the VM workshop. During the information phase, the students representing their roles of the project were asked to present the require-
Figure 1. Scenario for VM Workshop

The Client wishes to construct an Exhibition Centre (EC) for the Stonecutters Bridge and conduct a value management workshop for this project. The objective of the workshop for the EC is to identify and agree on the function for the EC design including parking facilities, decide whether a cafe facility and other leisure facilities should be provided based on the endorsed location of EC beside the western tower of the bridge. The workshop and meetings are designed to facilitate participants to understand better objectives and the functions of the EC.

The workshop will be facilitated by the Dr. Ann Yu and Mr. Thomas Lin and you are required to actively participate in the value management study including the pre-workshop, workshop and post-workshop phase. You are required to assign each of you a role of the project team members and act as a team of professionals which may client’s representatives, project manager(s), architect(s), engineer(s), quantity surveyor(s), landscape architect(s), government representative(s), other key stakeholder(s) and recorders to participate in two 3-hours value management workshops for EC.

Table 1. Workshop Agenda

<table>
<thead>
<tr>
<th>TIME</th>
<th>ACTIVITY</th>
<th>BY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Day 1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2:45 - 3:05</td>
<td>1. WELCOME AND INTRODUCTION</td>
<td>Facilitators &amp; Participants</td>
</tr>
<tr>
<td></td>
<td>• Welcome and participants in self-introductions</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Introduction to the agenda</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Facilitator role and rule of the game</td>
<td></td>
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<tr>
<td></td>
<td>• Confirmation of VM study objectives</td>
<td></td>
</tr>
<tr>
<td>3:05 - 3:45</td>
<td>2. INFORMATION PHASE</td>
<td>Participants</td>
</tr>
<tr>
<td></td>
<td>• Presentations by key stakeholders</td>
<td></td>
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<tr>
<td></td>
<td>• Clarification questions</td>
<td></td>
</tr>
<tr>
<td>3:45 - 4:00</td>
<td>3. Function Analysis Phase</td>
<td>Facilitator &amp; Client</td>
</tr>
<tr>
<td>4:00 - 4:15</td>
<td>4:00 - 4:15 Tea Break</td>
<td></td>
</tr>
<tr>
<td>4:15 - 5:00</td>
<td>5. CREATIVE PHASE</td>
<td>Facilitator &amp; Teams A &amp; B</td>
</tr>
<tr>
<td></td>
<td>• Identification of key areas for the achievement of our objectives</td>
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<tr>
<td></td>
<td>• Generation of ideas for the achievement of our objectives</td>
<td></td>
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<tr>
<td>5:00 - 5:30</td>
<td>6. EVALUATION PHASE</td>
<td>Whole Team, Facilitator &amp; Participants</td>
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<tr>
<td></td>
<td>• Review information and add ideas</td>
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<tr>
<td></td>
<td>• Put ideas in P1, P2, P3 categories</td>
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<td></td>
<td>• Cluster related P1 ideas together</td>
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<tr>
<td>Day 2</td>
<td></td>
<td></td>
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<tr>
<td>2:45 - 4:00</td>
<td>7. WORKSHOP CLOSING</td>
<td>Facilitator &amp; Participants</td>
</tr>
<tr>
<td></td>
<td>• Sum up &amp; Conclusions</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Feedback</td>
<td>Participants</td>
</tr>
<tr>
<td></td>
<td>• Questionnaire survey</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• End of workshop</td>
<td></td>
</tr>
<tr>
<td>4:00 - 4:15</td>
<td></td>
<td></td>
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<tr>
<td>4:15 - 4:45</td>
<td>8. DEVELOPMENT PHASE</td>
<td>Facilitator &amp; Participants</td>
</tr>
<tr>
<td></td>
<td>• Preparation of Action Plan</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Review of workshop objectives</td>
<td></td>
</tr>
<tr>
<td>4:45 - 5:15</td>
<td>9. WORKSHOP CLOSING</td>
<td>Facilitator &amp; Participants</td>
</tr>
<tr>
<td></td>
<td>• Sum up &amp; Conclusions</td>
<td></td>
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<tr>
<td></td>
<td>• Feedback</td>
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<tr>
<td></td>
<td>• Questionnaire survey</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• End of workshop</td>
<td></td>
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</tbody>
</table>
project. A table with actions, by whom and by when was completed by the students as a group. The students were instructed to submit a group VM workshop two weeks after the workshop in the post-workshop phase.

Apart from the students were expected to familiarized with the VM methodology, they were required to develop team building skills, intellectual skills, communication skills and professional competence. Feedback and comments were given to the students at the end of the workshop. After active participation in the VM workshop activities, students are able to familiarize with the VM methodology and job plan. They have better ideas of how VM workshops are organized, held and facilitated by the facilitators. Students of undergraduate level are not expected to learn the facilitation skill, therefore the subject lecturer acts as the facilitator. However, students are expected to understand the team dynamics and to perform as a team to solve problems.

This workshop is considered as an important element of the subject and the students’ attendance to the workshop is compulsory. The individual workshop performance of students contributes towards 50% of the coursework assessment while the VM group report contributes 25% and the remaining 25% is based on the MC test.

Feedback from the students

The students welcome the addition of VM workshop which facilitates their understanding of the VM methodology and process of workshops in the curriculum. A feedback questionnaire was administrated to collect individual views and recommendations from the students who participated in the workshops in 2007 and 2008. Questions measured quantitatively was listed in Table 4. The students were also asked to answer the questions qualitatively:

- What are the things that you like MOST in the workshop?
- What are the things that you like LEAST in the workshop?
- What are the things that you found INTERESTING in the workshop?
- What are the things that you found DIFFICULT in the workshop?
- What are your comments or suggestions to improve the workshop?

The feedback on the VM Workshops from the students (total no = 66) in 2007 and 2008 is summarized in Table 3. On the whole, the students were satisfied with the execution of the workshops (Mean = 4.23) as well as the techniques of VM used in the workshop. They agreed that these workshops should continually be conducted for the value management subject in the subsequent academic years.

In addition, a comparison of the results of the student feedback between 2007 and 2008 were carried out. Basically, the results were consistent except with “the workshop is fully supported by relevant participants” and “functions are clearly identified”. The students in 2008 formed a group of 11 and this small class required everyone to actively participate in the workshop in order to achieve successful workshop. However, one or two students were quite passive probably because he was a foreign student and could not actively participate in the discussion with the local students. The students in 2008 faced the difficulties in the function analysis phase. A verb-noun dictionary will be useful to students in identifying, clarifying and presenting the functions of the projects. More time shall be allowed to explain functions and demonstrate how to produce functional hierarchy in the future workshops. During the development phase, action plan will be prepared based on the specific ideas generated in the creativity phase instead of identifying actions referring to the project generally.

In the 2007, the VM workshop lasted for 3 hours and the students suggested extending the time of the workshop such that they could have more experience with VM process. In 2008, the timing of the workshop was increased to 6 hours in two separate sessions. The students recommended changing to one day workshop such that they could experience the VM process without interruption of other works for the continuity of the whole process. This recommendation will be considered and incorporated in the following academic years. A management laboratory with proper facilities will be arranged to hold the VM workshop instead of holding the workshops in the classrooms. The students also suggested feedback shall be given to them at the end of each phase instead of towards the end of the workshop because memory of the activities in the previous phase is still fresh at this time.

Conclusions and Recommendations

Intended learning outcomes are needed to initiate students’ learning and to maintain students’ engagement with the subject. Under the new outcome based curriculum in the Hong Kong Polytechnic University, the learning outcomes of the Value Management subject at Department of Building and Real Estate have been designed. A syllabus and teaching schedule are established together with textbook and other teaching materials for the students. The outcomes are evaluated by formative and summative assessments to determine the knowledge levels and behavioral change of students, to provide appropriate feedback and remediation to students, and to identify insufficient curriculum contents and ineffective instructions. Evaluation of teacher performance is also carried out to improve future pedagogic settings.
The result of a survey of the students’ feedback on VM workshops in the subject for the past two years is also provided. The students believed that value management workshops are essential in the subject and they are satisfied with the approach in conducting the workshops. They expressed that it was a valuable experience to participate in the VM workshop which enabled them to have a better understanding of the subject. Improvement such as the time, venue and process of workshop will be incorporated in the future VM workshops. The students also suggested feedback shall be given to them at the end of each phase instead of towards the end of the workshop.

Table 3. Results of Feedback Questionnaire for VM workshops

<table>
<thead>
<tr>
<th>No.</th>
<th>Question (paraphrased)</th>
<th>Max.</th>
<th>Min.</th>
<th>Mean</th>
<th>SD.</th>
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<td>5</td>
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<td>4.42</td>
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<td>5</td>
<td>2</td>
<td>4.03</td>
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<tr>
<td>7</td>
<td>The workshop is fully supported by relevant participants</td>
<td>5</td>
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<td>4.17</td>
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<tr>
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<tr>
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<td>13</td>
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<td>5</td>
<td>3</td>
<td>4.17</td>
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<tr>
<td>14</td>
<td>Functions are clearly identified</td>
<td>5</td>
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<td>3.94</td>
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<td></td>
<td>Creativity Phase</td>
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<tr>
<td>15</td>
<td>Satisfied with the techniques used</td>
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<td>3</td>
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<tr>
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<td>4.30</td>
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<td>17</td>
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<tr>
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<td>19</td>
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<tr>
<td>20</td>
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<td>1</td>
<td>3.74</td>
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<td></td>
<td>Benefits of VM</td>
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<td></td>
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<tr>
<td>21</td>
<td>Identification and clarification of client requirements</td>
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<td>3</td>
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<td>4.17</td>
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<tr>
<td>23</td>
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<td>4.35</td>
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<tr>
<td>24</td>
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<td>25</td>
<td>Expedition of decisions</td>
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<td>3</td>
<td>3.83</td>
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<tr>
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<td>Overall</td>
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<td>26</td>
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<td>3</td>
<td>4.23</td>
<td>0.576</td>
</tr>
</tbody>
</table>

(n = 66, 1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, 5 = strongly disagree)

References
Educational Development Centre (EDC) (2005) PolyU policies, regulations and guidelines on teaching, The Hong Kong Polytechnic University, Hong Kong.


<table>
<thead>
<tr>
<th></th>
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<td>0.396</td>
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<td>3.73</td>
<td>0.527</td>
<td>2.004</td>
<td>0.049*</td>
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</table>

**Information Phase**

| 8   | Satisfied with the techniques used                                                    | 4.02        | 3.91        | 0.109           | 0.625 | 0.534           |
| 9   | Satisfied with interaction between participants                                         | 4.20        | 3.91        | 0.291           | 1.251 | 0.215           |
| 10  | Satisfied with clarification of client’s objectives                                    | 4.00        | 4.18        | -0.182          | 0.783 | 0.437           |
| 11  | Clear about the given/assumptions of the project                                       | 3.80        | 3.73        | 0.073           | 0.327 | 0.745           |

**Function Analysis Phase**

| 12  | Satisfied with the techniques used                                                    | 4.16        | 4.00        | 0.164           | 0.784 | 0.436           |
| 13  | Satisfied with interaction between participants                                         | 4.22        | 3.91        | 0.309           | 1.519 | 0.134           |
| 14  | Functions are clearly identified                                                       | 4.06        | 3.36        | 0.692           | 3.063 | 0.003*          |

**Creativity Phase**

| 15  | Satisfied with the techniques used                                                    | 4.13        | 4.36        | -0.236          | 1.153 | 0.253           |
| 16  | Satisfied with interaction between participants                                         | 4.29        | 4.36        | -0.073          | 0.286 | 0.776           |

**Evaluation Phase**

| 17  | Satisfied with the techniques used                                                    | 3.95        | 4.00        | -0.055          | 2.55  | 0.800           |
| 18  | Satisfied with interaction between participants                                         | 4.24        | 3.82        | 0.418           | 1.803 | 0.076           |

**Development Phase**

| 19  | Satisfied with the techniques used                                                    | 3.62        | 3.64        | 0.0018          | 0.800 | 0.943           |
| 20  | Satisfied with interaction between participants                                         | 3.75        | 3.73        | 0.018           | 0.063 | 0.950           |

**Benefits of VM**

| 21  | Identification and clarification of client requirements                                | 4.09        | 4.09        | 0.000           | 0.000 | 1.000           |
| 22  | Improve communication and understanding                                               | 4.13        | 4.36        | -0.236          | 1.153 | 0.253           |
| 23  | Brainstorming ideas, options and alternatives                                         | 4.33        | 4.45        | -0.127          | 0.783 | 0.455           |
| 24  | Considerations of options                                                             | 4.04        | 3.82        | 0.218           | 1.045 | 0.300           |
| 25  | Expedition of decisions                                                               | 3.87        | 3.64        | 0.236           | 1.153 | 0.253           |

**Overall**

| 26  | Satisfied with the VM workshop on the whole                                           | 4.25        | 4.09        | 0.164           | 1.330 | 0.394           |

(* significance less than 0.05 indicate significant difference of means statistically)


Author Details

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ABSTRACT

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The VE Workshop at McGill University: Benefits for Students and Industry

Vince Thomson

Abstract

The McGill University Value Engineering Workshop provides a unique forum for the interaction of students and industry towards solving a real world problem given by a company. All participants learn the value engineering (VE) methodology, but mostly they learn cooperation and a team approach to solving problems. The mutual exposure raises the engineering professionalism of the students, provides solutions to problems for companies, and contributes to the education process. Companies of all sizes have participated in the workshop over the years, obtaining significant value enhancement to product design, manufacturing processes and services, as well as learning the VE methodology. Typical VE projects are described and some pedagogical benefits of the way the course is organized are given.

Keywords

Value engineering, education, MOD I, student project, university course

Introduction

The Department of Mechanical Engineering at McGill University has operated a workshop for value engineering for the past 35 years. During this period 200 projects have been done in collaboration with industry. The combination of value engineering and industry-university cooperation is unique. The objective of the workshop is to provide a forum for a high degree of interaction between students and representatives from industry. It also trains students and company employees in a systematic, optimization technique for problem solving, value engineering.

The McGill University Value Engineering Workshop is the only university course where company representatives sit together with senior Mechanical Engineering students to solve a common problem: a real-life project selected by a company. At the end of the workshop, each company has one or more specific solutions available which will improve the value of the subject of the study, be it a product, manufacturing process or service. The results are presented by the students to company management both as a presentation at a group session and in the form of a report.

The rest of this paper will describe the McGill Value Engineering Workshop in more detail, give the benefits for industry and students, and outline some typical projects. A discussion section presents some of unique features of the course along with some of its pedagogical advantages. Finally, conclusions are given.

McGill VE Workshop

The workshop is led by a Certified Value Specialist (CVS) and it is certified by the CSVA (Canadian Society for Value Analysis) and SAVE (the Society of American Value Engineers) as Module I towards the requirements for becoming a CVS. In order to accommodate participation by industry, the workshop consists of five sessions of eight hours for formal teaching on value engineering methodology and group problem solving. The workshop sessions are from 1:30 to 9:30 p.m. on selected Mondays during the fall semester. Due to the long sessions, it is the only course at McGill where coffee and doughnuts as well as an evening meal are provided for participants!

The five sessions given during the semester closely follow the five-step job plan of Larry Miles, the originator of value engineering, ending in the Presentation and Reporting Phase. At the end of the course, the students give a final presentation in front of representatives from all the sponsoring companies at a hotel near the university. The companies are also given a final report containing a description of the problem, the results of the value engineering analysis, a set of alternative solutions to the problem, and recommendations for action. Besides the five sessions, usually the value engineering team meets on other occasions to see the problem first-hand at the company site, to review research done by the student team, and to coordinate investigations.

The Value Engineering (VE) Workshop is also unique in the way that it is graded. There are no tests or exams. 60% of a student’s grade is obtained from the final presentation and report, and 40% is obtained from an evaluation of student performance by industry participants.
Industry Benefits

There are many benefits obtained from the VE Workshop for both company representatives and students. The main one is the mutual exposure between future and practicing engineers. For companies, they additionally benefit from the training in VE methodology. For some, it is their first exposure to VE; for many, the company knows of or uses VE, but it is new to the participants in the Workshop. Companies, then, learn a systematic method for improving product or process value, which is strongly suggested to be used on an ongoing basis within the company. Individuals obtain training and certification in value engineering.

The company also benefits from the research done by students. Often, companies have problems where significant investigation is necessary, but there may be neither the time nor resources to do it. Thus, a problem is investigated and solved in the Workshop which may not be looked at otherwise. Also, in many cases students provide a fresh outlook on a problem, so that a novel solution is obtained.

Additionally, company employees are exposed to students. They see students in action, students who could be future employees. Companies also contribute to the education process by being involved in the VE course.

An impressive track record has been logged during the 35 years that the course has been offered. The 200 projects have delivered significant value to the participating companies. The financial return is customarily measured over a five-year period, and is compared to the necessary investment, including the cost of sponsoring the Workshop. In the year 2000 session, the combined five-year return for six projects was $15 million, accomplished with a total investment of $500,000. This represents a return on investment of 30:1. Additionally, over the years, companies have hired many of the students with whom they have worked during the VE Workshop.

From surveys of past projects, companies implement about 50% of the recommendations. This is quite good compared to the success rate of improvement projects anywhere. Many times, projects are not implemented due to the low value of some recommendations and also due to changing conditions between doing the VE project and scheduling the implementation of recommendations.

Student Benefits

Students benefit from the VE Workshop
- by learning the value engineering methodology,
- by developing analytical and investigative skills,
- by obtaining experience on a real world problem,
- by having exposure to the current, industrial standards in engineering professionalism, and
- by seeing the business and technical operations of a company.

Typical Projects

Over the years, companies of all sizes have participated in the VE Workshop. A very wide range of problems has been investigated: new designs for products, manufacturing processes, and business services, as well as redesigns of existing products and processes.

Below is a list of organizations and the problems investigated for the past three years. (See Table 1.) The list contains five small, two medium and six large companies as well as one

### 2005 Projects

<table>
<thead>
<tr>
<th>Company</th>
<th>Project Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bechtel Corporation</td>
<td>Reduction cell off-gas energy recovery systems and applications</td>
</tr>
<tr>
<td>Bombardier Aerospace</td>
<td>Reducing time for making custom furniture for business aircraft</td>
</tr>
<tr>
<td>Cryocath Technologies</td>
<td>Optimization of the catheter manufacturing process</td>
</tr>
<tr>
<td>Industries Alternativ</td>
<td>Optimizing battery systems for electric vehicles</td>
</tr>
<tr>
<td>McGill VERT</td>
<td>Drive train design for electric vehicles</td>
</tr>
<tr>
<td>Transport IVF</td>
<td>Redesign of a transport in vitro fertilization incubator</td>
</tr>
</tbody>
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### 2006 Projects

<table>
<thead>
<tr>
<th>Company</th>
<th>Project Description</th>
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<tbody>
<tr>
<td>123 Certification Inc.</td>
<td>Assembly line for a virtual welding simulator</td>
</tr>
<tr>
<td>CMC Electronics</td>
<td>Cost reduction of an electronic flight bag</td>
</tr>
<tr>
<td>MAAX</td>
<td>Standardization of shower parts across products</td>
</tr>
<tr>
<td>Mitec Telecom</td>
<td>Cost reduction of a Ku-band transmitter</td>
</tr>
<tr>
<td>McGill VERT</td>
<td>Continuously variable transmission for an electric motor</td>
</tr>
<tr>
<td>Tecsult International</td>
<td>Specifying a section of highway in Algeria</td>
</tr>
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</table>

### 2007 Projects

<table>
<thead>
<tr>
<th>Company</th>
<th>Project Description</th>
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<tbody>
<tr>
<td>123 Certification Inc.</td>
<td>Design optimization of a portable welding simulator</td>
</tr>
<tr>
<td>Groupe Tekdata Inc.</td>
<td>Automated storage and retrieval system for metal sheet (2 projects)</td>
</tr>
<tr>
<td>Jitech</td>
<td>Gantry robot for the fabrication of structural steel</td>
</tr>
<tr>
<td>McGill VERT</td>
<td>Value increase for an electric snowmobile</td>
</tr>
<tr>
<td>Rolls-Royce Energy</td>
<td>Cost reduction and design for manufacture for a Trent engine flow straightener</td>
</tr>
</tbody>
</table>

Table 1. Typical Projects
university research group. All are from the Montreal area. Of the projects investigated, fourteen were for product design (5 new designs, 9 redesigns), and four were for manufacturing processes (1 new process, 3 existing processes). There were no projects for service improvement, although these have been done in the past. The list is quite representative of the type of companies that have participated in the VE Workshop over the years and the types of problems they wanted investigated.

**2007 Project Descriptions**

To see the content of typical projects, a brief description of the projects done in 2007 is given. These projects are fairly typical in scope, the level of detail during the study, and the success of results.

**123 Certification Inc.**

Design optimization and value increase of a portable welding simulator: 123 Certification Inc. produces welding simulators for teaching welding. The main objectives for the value engineering of the portable welding simulator were to realize a total weight of less than 32 kg (limit for check-in luggage for air travel), to maintain an appropriate, overall package size (limit for check-in luggage for air travel), to have good ergonomics for use during training, and to be easy to set up from its folded travel case. The student team was able to realize these objectives as well as to design the product with off-the-shelf components and to achieve the specifications for product reliability and durability.

**Groupe Tekdata Inc.**

Automated storage and retrieval system for metal sheet: Tekdata is a provider of engineering and manufacturing services to the transportation, telecommunication and medical industries. Due to its experience with sheet metal, the company wished to develop a commercial automated storage and retrieval systems (ASRS) for the handling of sheet metal. Two VE projects were performed with separate designs. In each case, stacks of sheet metal are placed on standard pallets, and stored and retrieved from a set of shelves.

In one case, there is a single rack of shelves which is loaded from one side (loading bay) by a forklift truck and automatically retrieved from the other side (shop floor) by a device which moves up and down the frame of the shelves. The pallets sit on the shelves with the long side of the pallet facing the outside of the shelf.

In the second case, there are two racks of shelves facing each other. The pallets sit on the shelves with the narrow side of the pallet facing the outside. A robot moving between the shelves automatically loads and unloads pallets onto and from the shelves.

**Jitech**

Gantry robot for the fabrication of structural steel: Jitech does engineering and cutting of steel beams in preparation for assembly in the field. In the steel plasma-cutting and welding industries, the only automated system in existence is for the cutting of 2D steel shapes. Jitech wants to create a fully automated, robotic system for the 3D cutting of steel I-beams, box-beams, and cylindrical beams. To do this, a beam needs to be placed, scanned, and have the scanned, 3D profile reconciled with the CAD model of the beam. The cutter can make a precise cut by factoring in any discrepancies between the two geometries.

The VE team evaluated several possible solutions and specified a two armed gantry robot with 3D scanner and tool changer. Among the tools were a plasma cutter and welder. The system is able to cut the necessary holes and notches into the surfaces of the steel beams, and then, weld brackets necessary for final assembly into place.

**McGill VERT**

Value increase for an electric snowmobile: The McGill VERT project does research on electric and hybrid vehicles. One of these is a fully electric snowmobile. There is an annual SAE Clean Snowmobile Challenge, in which the McGill VERT team participates. The VE team was asked to analyze the current snowmobile and use the VE process to make suggestions for the 2008 competition. Specifically, the team was asked to decrease the weight and the cost of the snowmobile, as well as to optimize the electric snowmobile according to the competition criteria.

The VE team made several suggestions for the electrical and mechanical systems, and the body/design to increase the value of the snowmobile to have the most competition points. Suggestions included: a skirt to minimize noise, the secondary ratio in the drive train be returned to the stock configuration to improve performance, the reduction of the size of the chassis to lower cost, an increase in the number of batteries to improve the range of the snowmobile, and the removal of an on-board charger to save on weight.

The McGill VERT team has participated in the VE Workshop from 2005 to 2007 to improve the design of their electric snowmobile. During this period, they won the SAE competition every year. In addition, the McGill snowmobile is used to support research in Greenland, where different performance criteria are required. The VE team also made a separate set of suggestions for improvement of this snowmobile.

**Rolls-Royce Energy**

Cost reduction and design for manufacture for a Trent engine flow straightener: Rolls-Royce is a leader in producing gas turbines for energy production. The VE team was asked to
improve the manufacture of the Trent engine flow straightener in order to reduce cost. The flow straightener breaks up the large vortices created in an elbow-shaped channel after the last compression stage and before combustion. The original cost of the flow straightener was driven by the time consuming nature of its manufacturing process.

The VE team explored new designs and manufacturing techniques, and performed detailed aerodynamic and stress analyses to assess whether proposed designs would fulfill the required aerodynamic and stress requirements. A cost analysis determined that a sheet metal design was best since it did not require any major, initial investment in custom tooling, as casting would have. The sheet metal design achieved major cost reduction, surpassing the initial objective of 50%. The material was changed from Inconel 625 to Stainless Steel 310 to reduce cost and still offer acceptable performance.

Discussion

There are several benefits for students and industry in taking the Value Engineering Workshop. The following section will discuss some of these from the point of view of the pedagogy and organization of the course.

One of the main benefits of the Value Engineering Workshop is the mutual interaction of students and representatives from industry. In most cases, industry representatives are engineers involved in the design of either product or production process. The original objective in starting the course was to provide an opportunity for students to work with company engineers in order to be exposed to the practices used in real world projects. This has two aspects. The first is the level of professionalism required for performing in projects. Although students do engineering projects as part of their university courses, they are not exposed to many of the various skills required to be able to successfully execute projects. In participating in projects with working engineers, students see the level of responsibility taken on by individuals and groups. There is also the breadth of detail involving different departments and disciplines required for projects to be implemented well inside a company. Value engineering provides a detailed methodology for organizing and executing a development project from the point of view of the design of the product. Therefore, the methodology not only helps students to perform the project at hand, but is also very valuable throughout the student’s life as an engineer.

The second aspect of exposure to real world practices are the specific engineering methods used in product and process development. In performing projects in university courses, students are exposed to a limited number of methods for the development of designs and production processes. Doing projects defined by companies and working with company engineers provide exposure to new design requirements and the use of new techniques to develop them.

Most university courses are taught as one hour sessions three times a week or 1.5 hour sessions twice a week, or even as three hour sessions once a week. Because of travel time, this format is not convenient for company engineers to participate in university projects. As a consequence, the Value Engineering Workshop is organized as 5 sessions of 8 hours. This satisfies the time requirement for university courses and the small number of sessions makes it easier for companies to attend. Moreover, the use of five sessions aligns well with the value engineering methodology.

The McGill Value Engineering Workshop follows Module I of the certified value specialist (CVS) training and is thus a certified course. This makes participation in the course more attractive to company employees since certification adds to their credentials. It is also attractive to students since it makes them more marketable when they graduate. This requires the hiring of a CVS in order to teach the course. For each of the five sessions, the first 1.5 to 2 hours is used to teach the step of the VE methodology to be used that day. The student teams work on their projects with the company engineers for the rest of the session. During the session, the CVS, professor and another practicing engineer visit all the groups several times to make certain that they understand and are following the VE methodology. The three also help the students when it comes time to do research to find alternative solutions for their problem. Assistance usually addresses different mechanisms, material selection, manufacturing processes, and analyses like stress and heat transfer. Due to the intense nature of the course, participation is limited to 6 groups of 5 students each.

One of the highlights of the course is the formal presentation to peers and company representatives. A formal presentation emphasizes the persuasion element of improvement projects and the importance of convincing others about the benefits of a particular solution. In order to better perform during their presentation, students make a trial presentation the week before the formal presentation. This helps them practice; it also allows them to determine the critical issues in their presentation. They get feedback from the three instructors on how to improve the content, the visualization, and the delivery of the presentation.

Finally, one of the significant benefits of the Value Engineering Workshop is the value engineering methodology itself. The combination of function and cost analysis has proven powerful over time for producing organized thinking about problems and solutions. The Workshop stresses the use of functional analysis for the problems at hand. When taking the VE Workshop, the students have already had exposure to cost analysis from work on other projects. Due to their engineering background, the students learn the VE methodology and
apply it relatively easily. The methodology serves them well during the project in the VE course as well as in other projects that they do later at university. From feedback from graduates, the students continue to use the VE methodology in projects during their careers.

Conclusion

Over the past 35 years, the McGill University Value Engineering Workshop has been very successful in providing

- training for students and company representatives in value engineering methodology,
- significant value in the solutions to company problems, but mostly
- a unique opportunity for interaction between students and industry.

As mentioned earlier, the student teams make presentations to show their improved designs and how the value engineering methodology helped their efforts in front of representatives from participating companies. In 2007, the presentations were scheduled as part of the annual conference held by the Canadian Society for Value Analysis (CSVA). Representatives from the CSVA judged the presentations and gave the CSVA Pfeiffer-Wales Award for Best Presentation¹. The award was shared by the two teams, who worked on the 123 Certification Inc. and McGill VERT projects. Judges and conference attendees commented on the high level of professionalism displayed in the presentations and the enthusiasm shown by all the participating student teams.

Endnotes

¹ David Pfeiffer, Mechanical Engineering professor, and Hank Wales, Certified Value Specialist, were the instructors for the McGill VE Workshop for its first 22 years.

Author Information

Vince Thomson is the Werner Graupe Professor for Manufacturing Automation (research chair) in the Department of Mechanical Engineering at McGill University. He has been involved in manufacturing and information technology related research for the past 25 years at McGill and the National Research Council (Canada). He is involved in manufacturing research including fabrication, shop floor control, production scheduling, and process management for manufacturing, engineering and business processes. In the area of value engineering, he has taught the course, Value Engineering Workshop, which is equivalent to MOD I, since 1995. He has also used functional analysis as part of his research.
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Value Added Strategies to Sustain a Successful Value Improvement Program

John L. Robinson, PE, CVS-Life

Abstract

We have all seen and many have enjoyed the fruits of successful Value Programs. We have also watched time and time again as these successful and robust Value Programs gradually spiral downward until they are no longer considered viable or beneficial. This paper addresses how actions can result in unintended consequences that contribute to the downfall of a successful Value Program. The paper will discuss many of the common compromises that are made relative to the scope of the value effort and the consequences that result from these decisions. Further, the paper will provide value program coordinators and value consultants the knowledge, tools, and techniques to allow them to justify proper scoping of value studies to include such issues as required disciplines, number of team members, level of experience and expertise, and study duration.

Introduction

This paper is based on my experiences in working with many established Value Programs. Some of these Value Programs have been for specific capital improvement programs and others are agency-wide long term and continuous programs. Some of these Value Programs have been established because of federal or state mandates while others are self imposed. I have been employed as a value engineering project manager and team leader within an agency-wide program and have provided services to these programs as a consultant.

I have also developed guidelines, procedures, and staff training for the start-up of two agencywide Value Programs. Both of these programs have been in existence for 10 to 15 years and both have reported an annual return on investment resulting from the implemented value alternatives of 50 to 1 or more.

It is from the breadth and depth of my experiences that I offer the following observations, insights, and suggestions on sustaining or building a successful Value Engineering Program. While this paper is focused on multi-project type programs, much of what is presented is equally applicable to any single project as well.

Anatomy of a Successful Value Program

Before discussing how to sustain a successful Value Program, it is important to establish a baseline for what constitutes a successful Value Program. Fundamentally, there is a value culture within the organization. Value Improvement through the application of the Value Methodology is an integral part of the project development process. Below are some of the characteristics of a successful Value Program:

- The Value Program is supported and encouraged by top management but perhaps more importantly by middle management and perhaps more important yet, by project management.
- Project managers take responsibility for the value study effort on their projects and consult with value professionals (in-house or consultant) to discuss plans and to establish proper budgets and schedules for the value effort at the onset of the project.
- The timing of value studies is scheduled within the project development process to achieve optimum results.
- Multiple value studies are conducted at various stages of project development on larger projects.
- The value effort is adequately funded to allow participation on the Value Team from all appropriate disciplines as well as to ensure the necessary support is available from the Project Development Team.
- Adequate time is given for each value study to accommodate the process and to allow sufficient development of the value alternatives.
- There is a high rate of implementation of the value alternatives; 75% or better.
- There is a return on investment for the cost savings generated to the cost of executing the Value Program of at least 10 to 1 (minimum).

This may be best illustrated by sharing how the Value Program works for one of my clients that I have served for over 13 years. For this particular organization, they have no one person designated as a “value engineering coordinator” nor do they have any state or federal mandate or even a writ-
ten policy requiring them to use value engineering. Instead, value engineering has simply become a part of their culture. This culture evolved because the General Manager and the Program Manager for a multi-billion dollar infrastructure program recognized the value in using this powerful process. Their interest, enthusiasm and encouragement were passed down to the project managers. The project managers in turn recognized the value of the process. Today each project manager approaches the value engineering effort with as much importance as they would any other part of the project development process. This value minded culture spans from the administrative assistants to the Chairman of the Board of Directors. Virtually everyone within the organization has been exposed to the process or the results of the process. The Chairman of the Board has actually served as a team member on two separate value engineering studies even to the point of developing the value alternatives during the Development Phase.

At the start of every value engineering study, the Program Manager always attends the kick-off and always opens the workshop with his words of encouragement to the value team, his staff, and the designers. He tells everyone that the reason they do value engineering on all of their projects is because they have found that their projects are always better as a result of the value studies than they would have been without the study. He further reinforces the designer by telling them that the findings of the value team will in no way reflect negatively on the designer’s work. He creates an environment where the value team is recognized as a subset of the larger project team.

Once the value study is completed, decisions on the value alternatives are made relatively quickly. My approach is to develop multiple alternatives, often developing alternatives that are not mutually exclusive. To assist the owner, the value team reviews the collective list of alternatives and identifies an optimum combination. This represents what the value team believes is the best value solution from the combination of alternatives. Typically, this client will accept and implement 80% to 100% of this optimum combination.

**Cultivate a Value Culture**

If a value culture is the fundamental building block of a successful Value Program, it is important to discuss what it takes to grow such a culture. Fortunately, by human nature, most people want to do the right thing. This is something that is instilled in us as children. Therefore, the seed to grow a value culture comes from a belief that integrating the use of the Value Methodology into the project development process will in turn benefit the project and those associated with the project. While on rare occasions some people can quickly grasp the concept of the Value Methodology and can clearly understand how it could work to improve value, most people need proof through demonstration and often it takes multiple demonstrations. Having been born and raised in Missouri, the Show-Me state, I understand this mentality all too well.

For this paper, we are assuming that we are past the initial hurdle of getting the opportunity to give a demonstration. Getting that first opportunity is the subject for another paper. Here I am taking the position that we have an on-going and active Value Program but we really do not have an established value culture where there is a positive, supporting, and encouraging attitude within the organization toward the use of the Value Methodology.

For a value culture to take root, people have to see the value of the program. To demonstrate the value, the process must produce value-added results. While cost savings is usually touted as the motive for having a Value Program, cost savings is rarely (perhaps never) the catalyst for igniting a value culture. What management and project management most often want from a value effort is:

1) Validation that the project is going to do what it is supposed to do (accomplish the function).
2) Innovation – identification of original ideas (creativity)

A value culture is founded on consistently producing meaningful and useful results that benefit the project, the organization, and the stakeholders. In my experience the inability of the organization’s Value Program to consistently produce value-added results is the primary reason that a value culture does not grow.

The other key ingredient to growing a value culture is value champions. There are those people in every organization that are described by words like: open-minded, forward-thinking, leader, visionary. These are people that others in the organization look to for direction; not necessarily because of their hierarchical position but because of their attitude and leader qualities. The Value Program needs these people to be champions for the program. If they see the value in the program they will share it and others will follow their lead. Again, while having champions in senior management positions can certainly be advantageous, it is more important that they are respected in the organization for their views and positions on issues.

**What Constitutes “ValueAdded Results”?**

As stated earlier, value-added results equate to those meaningful and useful results that can serve as the catalyst for creating a value culture in an organization.

What are perceived as value-added results are those alternative solutions that cause a paradigm shift in the minds of the project stakeholders. Paradigms are mental models we all have
that are created by the information filters in our brain. These filters or paradigms give us our perspectives. Project owners approach every project with their own individual and collective set of paradigms that effect the directions they give to their planning and design teams. These planners and designers bring to the project their own set of paradigms about how the project should be configured in order to solve the owner’s problem. Through the close working relationship between the owner and the designers, a new collective set of paradigms emerge. The only value alternatives that this project stakeholder team are going to perceive as beneficial, and worthy of implementation, are those that are successful in changing their paradigms about how the project should be configured. Every time the stakeholder team makes a decision together, new paradigms are formed or existing paradigms are confirmed. That is why value studies are generally more productive and more successful when done early in the project development; before too many decisions have been made and before the paradigms become too fixed.

Value alternatives that save cost without changing the project stakeholders’ paradigm may get accepted and implemented because they need to meet their project budget but they will not “feel” there was really any value added to their project. In their minds it will only be perceived as a necessary “cost-cutting” action and that in fact the value of their project was actually lowered. This is a common output of many value teams and it is a major contributor to the attitude that the value study was really not of any value to the project stakeholders.

Value-added results come from value alternatives that:

- Improve function performance
- Reduce or simplify operations and/or maintenance
- Provide innovative solutions to chronic problems
- Provide simple solutions to complex problems
- Increase the likelihood that the project will accomplish its intended function
- Provide solutions that bridge gaps between project stakeholders’ positions to create stakeholder consensus on a solution
- Provide solutions from original ideas that were never conceived of by the owner or designer

Fortunately, value practitioners are equipped with the most effective paradigm shifting technique known to man: Function Analysis.

Why do many Value Programs Fail to Produce ValueAdded Results?

The diagram below (Figure 1) is an influence diagram. Each factor is influenced by the preceding factor and in turn influences the following factor. More specifically, this is a reinforcing loop in that the cycle is self-sustaining. With a positive influence, the factors grow and with a negative influence the factors decay. Once the process is started, it will continue in that direction until there is in an intervention that breaks the cycle.

![Figure 1. Value Culture Loop](image)

As stated earlier, for a value culture to take root, people have to see the value of the program. For the program to be of value, it must consistently produce value-added results. This is where many programs fail. Organizations go through the motions with a half-hearted effort using people that are not prepared and or not qualified. When the results of these efforts produce meaningless or un-implementable alternatives, the value of the process is questioned. To succeed, we must break this cycle. This is certainly easier said than done.

Project Management’s Role

First let’s analyze how the organization’s project management contributes to this perpetual cycle. The project managers often create a self fulfilling prophecy: they expect nothing to come out of the value study therefore they under-resource the effort and the value study produces “expected” results; nothing of value. Unfortunately, most project managers lack the requisite expertise in the value process and the nuances of how to structure a value study for success. Instead, most are biased by
historically non-value-added results; therefore, the tendency is to minimize the “pain” and protect the expenditure of their project’s resources.

This attitude by the project managers manifests itself in under-resourced value studies. For example:

- Short duration workshops, often 1 to 3 days
- Small number of team members
- Not enough technical disciplines
- Inadequate level of technical expertise

Additionally, because the project managers often view the value engineering effort as a necessary evil, it is really the last thing they want to do. This is particularly true where the use of the Value Methodology is mandated within the organization. In this case, the project manager will first try every avenue to seek approval for not doing a value study. In anticipation of getting this approval the initiation of any value engineering effort is deferred. If senior management has a similar attitude, they approve the waiver from the mandate. This in turn encourages the project manager to ask for a waiver on the next project as well. Occasionally the waiver is not approved but now the project manager has delayed the value engineering effort until the project is in the final stages of design. Now all of the project decisions have been made and it will be extremely difficult to produce any significant value-added results because too many paradigms have been cast.

When the use of the Value Methodology is not mandated, many project managers will not consider a value engineering effort until the project is in financial trouble. Again, the perception is that the process does not add value but it can be effective at cutting cost. Therefore, they do not want to commit project resources to this activity unless they need some cost savings. Since it is usually late in the project development process before there is an admission that the project is in financial trouble, the value engineering effort is set up to deliver its expected results; cost savings but no value added.

The Value Methodology is one of those processes that, on the surface, seems so simple that everyone thinks they are an expert. Because these project managers really do not understand the value process well enough to know how manipulating the scope and timing can affect the outcome of the study, many studies are unknowingly set up for failure. I personally do not believe that “failure” is an intended outcome of their actions, it is simply a lack of understanding the consequences of their actions.

Since these project managers see little to no value in the Value Methodology it receives virtually no attention in the project development process, even when the value studies are mandated by policy, regulation, or law. Moreover, if senior management in the organization does not see the value either, then the project managers experience no repercussions for ignoring the policies.

**Value Practitioner’s Role**

Many value practitioners whether internal to the organization (in-house) or consultants are also complicit in this cycle of value engineering studies that produce little to no value-added results (refer back to Value Culture reinforcing loop diagram in Figure 1). First and foremost, they accept the assignment that has been improperly scoped by the project manager. Saying “No” can be a powerful message to the project manager. Accepting the assignment simply reinforces that the project manager’s perceived expertise relative to the level of effort required was correct.

If the value effort is poorly conceived then the value practitioner’s ability to produce value-added results is obviously constrained. But what if the project manager has established a proper scope, budget, and timing for the value effort, are value added-results guaranteed? Absolutely not; many times the value practitioners themselves are responsible for initiating or feeding the downward spiral or decay of the value culture loop. The value practitioner is vital to the value team’s ability to produce value-added results. Since all value practitioners are not created equal and not all have honed their Value Methodology and people skills to an expert level, owners experience a diversity of outcomes.

Here are some of the value practitioners’ common pitfalls:

1) Sacrificing or compromising steps in the Value Methodology. Obviously no one understands the benefit of the process more than the value practitioner leading the study. However, sometimes the value practitioners give in to pressures by the owner or even the team who challenge the process or certain process activities. For example, to expedite the process, the value practitioner identifies the functions for the team rather than making them struggle
to come to agreement on a verb-noun combination.

2) Poor execution of function analysis. Function analysis is the heart and soul of the Value Methodology. Unfortunately too many people believe they have it mastered after taking a SAVE certified Module I training workshop. This is only the beginning of the education process. A common mistake is using tasks or activities as functions. I once reviewed a report prepared by a prominent CVS team leader where there were multiple “functions” in the FAST diagram like: replace doors, replace windows, paint walls, etc. For the record, these are not functions.

3) Compromising process for product. Function analysis has two purposes: one is process (expand understanding) and the other is product (produce FAST diagram). Many practitioners wrongly put the priority on product rather than process. Process is critical to achieving value-added results. The finished FAST diagram is important to the SAVE Certification Board but is rarely important to the project stakeholders; value adding results are important to the project stakeholders.

4) Lack of innovation. Many value practitioners do not “push” the value team hard enough to seek the innovative solutions. Many value teams that are inexperienced at the process have a difficult time reaching beyond the low hanging fruit. Unfortunately these are usually the ideas the owner and designer have already thought about but chose not to implement. Other value practitioners mistakenly believe that generating a large number of ideas is synonymous with creativity and innovation.

5) Inadequate development of the ideas. I have reviewed many value study reports prepared by a wide variety of value practitioners from in-house staff to consultants. If there is one commonality it is the lack of development and documentation of the value alternatives. For many, the focus seems to be on quantity rather than quality. That may be an acceptable criterion for brainstorming but not for development. Therefore, the value alternatives are also perceived by the project stakeholders (owner, designer, etc.) as half-baked solutions and, unfortunately, many times they are correct.

Setting up a Value Study to Produce Value Added Results

To reverse or prevent a negative influence on our value culture loop, the key is to make sure the value effort is given every opportunity to create value adding results. So how do we increase the likelihood that a value study will produce what will be perceived by the project stakeholders as a value-added contribution to the project development? Let’s start with establishing a budget. This is not necessarily the cost for the value effort. The approach is to identify, at project inception, how much could be spent on the value effort based on a desired return on investment.

One of the most effective approaches is to use a return on investment (ROI) approach. It is very simple. Identify the desired ROI. A generally accepted ROI within the value industry is 10:1 which means that the value effort will return $10 in savings for every $1 spent on the value effort. This is very achievable and will usually exceed the expectations of the project manager. The next step is to estimate the anticipated savings (implementable) in terms of percentage of construction cost. This requires some experience. If in doubt, 5%-10% is usually a good estimate. Divide the potential savings by the desired ROI and you have a preliminary budget. This budget represents the amount that could be spent on the value effort with a high probability of delivering the ROI. Generally the budget for the value effort should be between ½% and 1½% of the construction cost.

Now that we have a preliminary budget, let’s establish a proper scope within the budget. It is paramount that the value practitioner give input to the project manager early in the programming and planning phases of the project development in order to influence the scope, budget, and timing of the value engineering effort.

If we break the scope down into its key components we get:

Example 1

Assumptions:
- New large diameter pipeline project
- Construction cost = $50 million
- Anticipated cost savings = 10% of construction cost
- Desired return on investment for the value effort = 10 to 1

Potential Savings:
- $50 million x 10% = $5 million

To achieve a 10:1 ROI, divide the potential savings by the ROI.

Potential budget for value effort = $5,000,000/10 = $500,000

In this example, the budget equals 1% of the construction cost. This is a reasonable upper limit. This does not mean the project manager needs to spend the entire amount—it is a budget.
- number and timing of workshops
- duration of workshops
- disciplines and number of team members
- level of expertise.

**Number and Timing of Workshops**

Many owners and project managers think that one value study is sufficient. That may or may not be true. Further, the study should be done at nominally 30%-35% design completion. From my experience, a project that is at 35% design completion has 70%-90% of the decisions already made. Remember earlier I explained that these decisions equate to paradigms, therefore it is difficult to affect change. For this reason, if only one study is going to be conducted, it should be toward the end of the planning phase. Based on the size and complexity of projects today, many projects will warrant multiple value efforts. From Example 1, experience would suggest that this project would return a benefit from three value efforts. The first should be conducted on the planning documents to validate the planning decisions and to optimize the plan. The second should be during preliminary design (prior to starting final design) to optimize the design at a systems level, and the third late in final design with a focus more on constructability. This level of effort would fit within the preliminary budget that was calculated in the example.

**Workshop Duration**

The project manager often wants the workshop(s) as short as possible to minimize the cost and disruption to the project schedule. Frequently, the argument will be made that the project is small, simple, straight-forward, etc., and will want to limit the workshop to 1 to 3 days in duration. The value practitioner needs to educate or inform the project manager that there is an internationally recognized standard for value engineering that has been developed by SAVE International, the professional society for value engineering. Most project managers are not aware that there is actually an international standard for the value study process that has been adopted by our federal government. This standard provides the protocol on how a value engineering study is conducted. To not follow this standard would be asking the value practitioner to not follow the generally accepted practices of the value industry. The value team needs time in the workshop just to execute the process activities. For a 5-day workshop these activities take approximately 50% of the workshop time. This percentage actually increases slightly as the workshop duration is shortened because there are portions of the process that cannot be appropriately reduced. Therefore it is not a linear reduction. Secondly, the value team needs sufficient time to adequately document the value alternatives; this takes the other 50% of the duration. Do not sacrifice this time. Explain to the project manager that this time is critical for the value team to make sure the value alternative concepts are fully developed by the team that conceived the ideas. This ensures that the value study does not present halfbaked solutions that waste the time of the project designers and other stakeholders to review and ultimately reject.

The project manager will often suggest using members of the design team to reduce the Information Gathering Phase of the process and also reduce the Development Phase since they can develop the value alternatives as part of their design process. This is seldom, if ever, a good idea. A tenet of the Value Methodology is that objectivity breeds innovation (ideas not previously identified). This is where a discussion on paradigms can be very effective. While some time can be saved, the potential loss in value from the value study is an order of magnitude greater if not more. Of course there are always exceptions to this rule but, if the objective is to set the stage for the value study to have the greatest likelihood for success, then we should reduce our risk of failure.

**Number of Team Members**

The project manager will typically want to minimize the size of the team to minimize the cost of the effort. The team should be sized considering: required disciplines, plus sufficient production capacity, plus team dynamics. List the major features of the projects and the disciplines required to review each of these features. Ask the project manager if he wants the value team to look at each of these features. If the answer is yes, then obtain his concurrence that it will require this list of disciplines. Depending on the size and complexity of the project or simply the nature of the project, it may be appropriate to have multiple people on the team for key disciplines. This serves multiple functions. For one, it provides greater potential for innovation by having multiple perspectives and experiences represented in the same discipline. Secondly it increases the team's production capacity to develop value alternatives in the project aspects where the greater number of ideas are likely to be generated. For example on a $100 million highway project there will likely be a large number of ideas related to roadway configuration, geometrics, etc., therefore multiple roadway design disciplines would be appropriate in order to make sure all of the worthy ideas are fully developed.

The final consideration is team dynamics. A significant factor in the effectiveness of the value process is the team synergy that is created. This synergy is the fuel for the creative process. It generally takes a minimum of five team members to stimulate the creative idea generation process. With this minimum number the team will start to build on each other's ideas and work together to create ideas that would not have been conceived by any one individual.
If the rationale above does not convince the project manager to provide a sufficient budget for the number of team members, use an economic justification similar to the one in Example 2. This often helps the project manager to see how trivial the cost of a team member is relative to the potential value they can bring to the project.

**Value Team Expertise**

The expertise of the staff on the value team is another critical ingredient to success. Particularly when value teams are staffed by the owner’s staff, there is a fairly common practice to use people that are the least busy—there are usually good reasons why these people are not as busy as others. This can happen with consultant teams as well. In most cases, the value study teams should be staffed by individuals with a level of experience and expertise that is at least equal to and preferably greater than the experience and expertise on the design team. Project manager level and design section leaders are usually the appropriate level of expertise. For some project features a more junior person may be adequate and for others it may be appropriate to seek out national or international level experts.

If the value team does not have adequate or equivalent expertise to the design team, it will become abundantly clear when they start asking questions during the Information Phase and when presenting the value alternatives at the end of the workshop. If the designers do not perceive the value team members as peers (relatively equal capabilities) or experts, the designers and owner’s staff will lack confidence in the results. For credible results, the value team must be able to stand toe-to-toe with the design team.

Furthermore, if the objective is to find possible solutions that have not already been considered, then it would be unreasonable to expect team members with limited experience and expertise to identify solutions that escaped the design team. A value team with an inadequate level of technical expertise will not be able to generate and develop the paradigm shifting value alternatives that will truly add value to the project. Beyond the technical expertise is the expertise of the value team leader. In my opinion, the value study should never be led by a person that is not a Certified Value Specialist (CVS). This is the highest level of certification given by SAVE International to demonstrate competency in executing the Value Methodology. With the simplified certification process in place today, it is not unreasonable to require this level of certification.

**Conclusion**

In conclusion, for any Value Program to be sustainable, a value culture must be established in the organization. In order to establish a value culture, the Value Program must be managed and the value studies executed in such a manner that value-adding results are the consistent outcome of these studies. This requires changing common project manager practices by integrating the value practitioner into the project development process to influence the scopes, budgets, and timing for value studies early in the project programming phase. It also means holding value practitioners to a higher standard of performance to ensure the Value Methodology is properly performed.

**Author Information**

John Robinson is a Principal and Owner of Strategic Value Solutions, Inc. John’s career includes more than 20 years dedicated to leading value engineering studies on public and private capital projects across the Continent. His education includes an engineering degree from the University of Missouri at Rolla. He is a registered professional engineer and a life Certified Value Specialist. John’s value engineering study experience includes major transportation projects, water and wastewater projects, marine and coastal projects, flood control projects, environmental restoration and much more. He also has extensive experience in military projects and other vertical construction type projects. The sizes of the projects and programs that John has conducted value studies on have ranged from a few hundred thousand dollars in capital costs to as high as $40 billion.
The Integration of the Japanese Tear-down Method with Design for Assembly and Value Engineering

James A. Rains, Jr., CVS-Life, FSAVE, PVM and Yoshihiko Sato, CVS-Life, FSAVE

Abstract

While working for Isuzu in the early 1970’s, Mr. Yoshihiko Sato first learned of tear-down methods from his association with General Motors (GM). Later Mr. Sato fully developed the tear-down methodology to become much more extensive and encompassing than the original version offered by GM. Since that time Mr. Sato has written several books and has offered training in his tear-down methods. Recently he has taught his methods in the USA and now has a book written in English, which is co-authored by J. Jerry Kaufman. In 2006, Yoshihiko Sato was brought to the USA by Jim Rains to teach and perform a full week tear-down workshop for an automotive supplier.

Based on the experience of working with Yoshihiko Sato, Jim Rains has been able to perform tear-down workshops with other companies. One of the elements of Sato’s tear-down method is Dynamic Tear-down. Since working with Sato, Rains has developed a Design for Assembly (DFA) module that he has inserted into Sato’s Dynamic Tear-down element. This DFA module has further enhanced the tear-down method. In addition Rains has experience of integrating value engineering with the enhanced tear-down method. The paper will describe the introduction of Japanese Tear-down into the USA and the enhancements that have been made as a result; including the integration of Tear-down/Design for Assembly and Value Engineering.

Description of Japanese tear-down

While working for Isuzu in the early 1970’s, Mr. Yoshihiko Sato first learned of tear-down methods from his association with General Motors (GM). Later Mr. Sato more fully developed the tear-down methodology to become much more extensive and encompassing than the original version offered by GM. Since that time Mr. Sato has written several books and has offered training in his tear-down methods.

In Sato’s book (J.J. Kaufman, co-author) the definition of VA Tear-down is “a method of comparative analysis in which disassembled products, systems, components and data are visually compared; and their functions determined, analyzed and evaluated to improve the value adding characteristics of the project under study.”

Process and Static. The relationship of these elements and how they relate to each other are shown in the following figure. The most common tear-down elements are Dynamic, Cost, Material and Static tear-down. It seems that the Matrix and Process tear-down (TD) elements are more suitable for companies that are advanced in these techniques.

Sato notes his opinion of the fundamental difference between US & Japanese Tear-down practices. “I believe that the Tear-down methodologies, as originated earlier in the US are basically of an “overall examination” type approach. This is the way we were impressed when GM brought it to us, in which we started to use any findings from there to be developed into improvement proposals. Meanwhile, the new approach to Tear-down as we developed (at Isuzu) is unique in that it takes a “comparative analysis” to be applied to competitors’ products specifically in such terms as Function, Cost, Material, Dynamic Process and Matrix. We determine what are specific strong-points (worth to be learned) and what are weak-points
to be corrected. Finally, all the problematic findings must be shared through Static viewpoints.

**The Tear-Down Elements Detail**

All TD elements require upfront planning and preparation. It is recommended that the preparation begins with the 5 Whys and 1 How as described in the Sato/Kaufman book. Once this information is developed then the actual planning of the products, competitor’s products and the workshop itself is necessary. This paper will not go into the detail of those upfront planning activities, except as shown in the examples located in the Appendix.

**Dynamic TD** – Dynamic TD applies the principle of comparative analysis to the assembly process. Essentially the comparisons are focused on the effort and time it takes to assemble and disassemble the products being studied.

**Cost TD** – The focus of the Cost TD element is to make detailed comparisons of your product components with that of your competitors. Each component part may have many slight differences. Each difference then is noted and a cost estimate for this difference is determined.

**Material TD** – Material TD focuses on material choices, material surface treatments and altering material chemical properties through various treatments such as heat treating and stress relief. Another sub-element of Material TD is to analyze material offal for metal parts and resin waste for injection molded parts.

**Matrix TD** – As mentioned earlier only more advanced companies that have already made an effort for part commonization will benefit from this element. Matrix TD will further de-proliferation efforts by reducing part numbers through the utilization of common parts on different products in the same or different product family. The utilization of carry-over designed parts to new product designs is also of benefit.

**Process TD** – Once part commonization is mastered, process standardization can also be mastered. When common processes can be institutionalized process development time and production rates can be minimized. This results in lower capital and tooling investments and in lower piece part costs. It also results in faster time to market, especially in a high capital intensive business.

**Static TD** – Static TD represents the original element of tear-down presented to Mr. Sato by General Motors many years ago. Yet as simple as this element seems, Mr. Sato was able to develop many improvements to that shown to him by GM. In Static TD the component parts are appropriately displayed to enable on-going investigation and cost reduction.

**Introduction of Japanese tear-down in the United States**

Several years ago, Yoshihiko Sato gave J. Jerry Kaufman and Jim Rains an initial draft of his TD book in English. While working simultaneously, Mr. Kaufman was able to secure a publisher and edit the initial draft into a book that was published in the US in 2005. At the SAVE International Annual Conference in 2005, Sato taught the first two-day again at the SAVE Conference in 2006.

In 2006 with the cooperation of Jim Rains, Sato was able to introduce his TD methods to an automotive supplier in the Detroit, Michigan area. To prepare for this workshop Rains reviewed and revised every PowerPoint slide and spreadsheet that was used in the above mentioned SAVE training class. Prior to this date, the materials used, were not completely converted to English text and grammar. The first USA workshop included three teams of approximately 24 people. Three different products were analyzed along with several respective competitor designs. The week long workshop provided training in each of the Japanese TD elements; however, only the Dynamic, Cost, some Material and Static elements were actually performed. This workshop was the first workshop of its kind in the United States. Sato and Rains have recently (June 2008) teamed up again to perform a workshop for a large manufacturing company. Based on the significant results from these workshops, it is safe to say that the Japanese TD methodology is meaningful and exceptional in obtaining competitive cost results for the company that invests in learning and using it.

**Design for Assembly**

“Dynamic TD is supported by commercially available computer software designed for Design for Assembly (DFA) criteria in that it can assess product designs in the same way”. With this in mind and Rains’ familiarity with DFA, he decided to essentially integrate this method of DFA in the Dynamic TD element. This DFA method, however, is not a computer software system, but a manual method that obtains the same desired result as the software. There are several design guidelines that come into play when using DFA. Some of these guidelines are:

Simplify the design and reduce the number of parts because for each part, there is an opportunity for a defective part and an assembly error. The probability of a perfect product goes down exponentially as the number of parts increases. As the number of parts goes up, the total cost of fabricating and assembling the product goes up. Automation becomes more difficult and more expensive when more parts are handled and processed. Costs related to purchasing, stocking, and servicing also go down as the number of parts are reduced. Inventory
and work-in-process levels will go down with fewer parts. As the product structure and required operations are simplified, fewer fabrication and assembly steps are required, manufacturing processes can be integrated and lead-times further reduced. The designer should go through the assembly part by part and evaluate whether the part can be eliminated, combined with another part, or the function can be performed in another way. To determine the theoretical minimum number of parts, ask the following:

- Does the part move relative to all other moving parts?
- Must the part absolutely be of a different material from the other parts?
- Must the part be different to allow possible disassembly?

Design for parts orientation and handling to minimize non-value-added manual effort and ambiguity in orienting and merging parts. Basic principles to facilitate parts handling and orienting are:

- Parts must be designed to consistently orient themselves when fed into a process.
- Product design must avoid parts which can become tangled, wedged or disoriented. Avoid holes and tabs and designed “closed” parts. This type of design will allow the use of automation in parts handling and assembly such as vibratory bowls, tubes, magazines, etc.
- Part design should incorporate symmetry around both axes of insertion wherever possible. Where parts cannot be symmetrical, the asymmetry should be emphasized to assure correct insertion or easily identifiable feature should be provided.
- With hidden features that require a particular orientation, provide an external feature or guide surface to correctly orient the part.
- Guide surfaces should be provided to facilitate insertion.
- Parts should be designed with surfaces so that they can be easily grasped, placed and fixtured.
- Minimize thin, flat parts that are more difficult to pick up. Avoid very small parts that are difficult to pick-up or require a tool such as a tweezers to pick-up. This will increase handling and orientation time.
- Avoid parts with sharp edges, burrs or points. These parts can injure workers or customers, they require more careful handling, they can damage product finishes, and they may be more susceptible to damage themselves if the sharp edge is an intended feature.
- Avoid parts that can be easily damaged or broken.
- Avoid parts that are sticky or slippery (thin oily plates, oily parts, adhesive backed parts, small plastic parts with smooth surfaces, etc.).
- Avoid heavy parts that will increase worker fatigue, increase risk of worker injury, and slow the assembly process.
- Design the work station area to minimize the distance to access and move a part.
- When purchasing components, consider acquiring materials already oriented in magazines, bands, tape, or strips.

Design for ease of assembly by utilizing simple patterns of movement and minimizing the axes of assembly. Complex orientation and assembly movements in various directions should be avoided. Part features should be provided such as chamfers and tapers. The product’s design should enable assembly to begin with a base component with a large relative mass and a low center of gravity upon which other parts are added. Assembly should proceed vertically with other parts added on top and positioned with the aid of gravity. This will minimize the need to re-orient the assembly and reduce the need for temporary fastening and more complex fixturing. A product that is easy to assemble manually will be easily assembled with automation. Assembly that is automated will be more uniform, more reliable, and of a higher quality.

Design for efficient joining and fastening. Threaded fasteners (screws, bolts, nuts and washers) are time-consuming to assemble and difficult to automate. Where they must be used, standardize to minimize variety and use fasteners such as self threading screws and captured washers. Consider the use of integral attachment methods (snap-fit). Evaluate other bonding techniques with adhesives. Match fastening techniques to materials, product functional requirements, and disassembly/servicing requirements.

The Manual DFA form we can use has a scoring system for each of the following categories.

- Part Needed - function can’t be consolidated because:
  1) Part must be of a different material
  2) Part must move relative to other parts
  3) Part must be different to allow assembly or disassembly
  4) Part is a purchased vendor catalog item
- Part Fabrication or Subassembly - part is easy to fabricate, adheres to DFM guidelines & has good yields. Geometric features are required & complexity justified by consolidation of multiple functions. Subassembly has minimum of parts and is easy to assemble.
- Part Handling - part can be easily gripped or held from pick-up through insertion. Part is presented or feed without interference with other parts, nesting or tangling. No effort to unpackage, remove protective material, or prepare. Part is not fragile or dangerous to handle.
Part Orientation - orientation is unambiguous or has a high degree of symmetry that makes orientation easy. If part must be asymmetrical, the features that define the asymmetry are obvious.

Part Size & Weight - size is neither too small or thin nor too large and heavy to handle manually. Does not require special tools (e.g., tweezers, lift, etc.) nor another person to handle. Part can be picked-up with one hand.

Assembly Access - top down assembly with a stable base component. No separate fixture required (self-fixturing). No reorientation of the assembly required to get access for installation or assembly. No blind assembly; can be seen and guided by operator or machine.

Part Insertion - part is easily aligned and inserted with a simple, straight insertion direction, no insertion force & plenty of clearance to operator & tool. Part features (e.g., chamfers, tapers, etc.) facilitate alignment and insertion.

Joining & Fastening - requires minimal effort. Integral attachment is the ideal with no separate fasteners or joining material. Avoid need for torquing or curing time. When fasteners are required, use common fasteners. Joining & fastening conforms to guidelines.

Adjust & Finish - assembly step/part doesn't require cleaning or finishing. Finish is robust to avoid special handling & wrapping to protect finish. Assembly step/part does not require final cosmetic inspection and retouching.

Mistake-proof - product or process design features prevent part from being incorrectly assembled and avoid the need for subsequent inspection or checking.

The scoring system is an example of the scoring for the above category of Part Insertion. Each component part of every competing design is scored using our DFA system.

- **0 points** - Part is easily aligned and inserted with minimal force
- **2 points** - Part lacks alignment or insertion features or is flexible
- **4 points** - Requires fixture/tool to align/insert; flexible; minimal clearance
- **5 points** - Difficult to insert; high insertion force; lacks clearance

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**Figure 2. Value Methodology Workshop Process**

*Value World*  
Volume 31, Number 3, Fall 2008  
29
The Integration of Teardown/DFA with VE

The authors strictly follow the value engineering job plan that is offered as the SAVE International standard. The major phases of this job plan are: Information Phase; Function Analysis Phase; Creative Phase; Evaluation Phase; Development Phase; Presentation Phase and Implementation Phase.

This job plan becomes the framework for the integration of the TD methodology and the DFA methodology. The TD and DFA activities are both part of the Information Phase. Once the product to be analyzed has been selected the first workshop is scheduled. This workshop is the Information Phase. All product samples (including the competitor’s) are collected. It is best to have more than one unit from each competitor, however, this is not always possible based on cost and size issues. After performance testing, these units are disassembled. Generic checklists are used to insure all data such as cost, drawings, quality detail, sales and marketing information of the company’s product is available. Another checklist of tools and materials for the TD/DFA workshop is available. Sample checklists are shown in the Appendix.

The TD workshop starts with presentation materials to get the workers in the correct mindset for design improvements. The Dynamic TD is usually done first. In this case most of the effort to perform the Dynamic TD is using our DFA manual worksheet. We compile detailed data on our own and each competitor’s products using our scoring system. Advantages and disadvantages of competitor’s products are discussed throughout this process. The next step is to perform the Cost TD. We use the form developed by Mr. Yoshihiko Sato. Our costed-bill-of-materials is listed first. Then a bill-of-materials (not costed) for each competitor design is created. Then part by part design comparisons are made to our design. We note every minute detail that is different. It is common to have many differences for each component part. These need to be listed individually. For each difference, we identify the cost variation from our design to the competitor’s design. This step is time consuming, but is extremely valuable in the information that is learned and what can be done to improve our own product. The improvements are only noted at this point. Since we are still in the Information Phase we are not necessarily looking for ideas or solutions, but merely collecting data and facts that will be used in the remainder of the VM job plan.

Material TD often requires special equipment and expert analysis. Generally most of this TD method is done at a later date, outside of the workshop environment. There will be, however, opportunities to identify and collect Material TD data and information. The final part of the workshop is to display all of the products components, including the competitors. This is called Static TD. There are proper and improper ways to display these component parts. Special care is to display the parts so that one can view the part from all sides and angles. Specialized board attachment methods have been developed to insure this happens.

Generally we recommend a one to two week lapse before completing the remainder of the VM job plan. With the Information Phase now completed the workshop continues with the Function Analysis Phase. The details of running this part of the workshop is essentially identical to running a VM workshop that does not include tear-down and DFA as part of the Information Phase. The issue is that now that we have so much more information each phase of the job plan takes a bit longer. Depending on the size and scope of the project under study, no less that four days needs to be devoted. An enhancement to this activity would be to perform a FAST diagram and cost-function analysis on each of the competitors designs. Depending on the product complexity and the number of competitor’s products analyzed this can add 3 to 6 days to the process.

The remaining VE job plan phases are followed as normal. Special care however, in the Evaluation Phase is necessary to correct any design deficiencies noted in the DFA effort. Also using the Cost TD information, the team must insure that all areas of potential improvement have been addressed.

Examples of Successful Tear-down Applications in Japan

Product development phase: The Comparative Analysis is applied as early as the pre-design phase, where materials, product configuration, and what will be product functions are analyzed. The results of the analysis should be reflected in product merchandising plans. These are unique points of our approach, which cannot be found in the western world use of Tear-down. Based on the data collected through the comparative analysis, Tear-down Targets for each Function, Cost and Product weight, respectively, are established. This specific goal data is to be importantly used in the company’s overall Target Costing Activity.

Product design phase: It goes without saying that those “strong-points” found in the competitor’s products are not to be merely “copied”, but are to be used to create “new associated ideas” so that our products can be made superior over those of the competition.

Product verification phase: Tear-down efforts can be extended even in this phase by taking up competitors’ newest products to check if our products are still better. Any qualitative targets, so far unclear, are to be cross-examined with competitors’ products. The results of such comparison should be used in making company’s products marketing/sales strategies more effective.

Other phases:
Employee training: Tear-down findings such as functions, configurations, materials, fabrication methods, etc. can be utilized in developing company's new-employee training programs.

Dealer collaboration activities: Collected competitor information can be utilized in such joint activities as teaming up in product development, creating future-oriented strategies for parts suppliers, etc. It is helpful in making them discover what are new hints for solution, what should be taken up for joint product development, etc.

In-house and other communication: Tear-down information is helpful in promoting communication between top executives and field staffs, inter-departmental exchanges, smoother member-to-member sharing of first-line data, building better communication channels with dealers, etc.

Design for Manufacturability

A future enhancement that is not detailed in this paper is once the final design concept has been determined, it is then very useful to utilize the Design for Manufacturability (DFM) techniques for each and every component part or sub-assembly. The Advanced Value Group, LLC working in conjunction with DRM Associates offer detailed DFM training. Our DFM training modules include:

- Design for Automated and Robotic Assembly
- Design for Electronics
- Design for Machining
- Design for Sheet Metal
- Design for Injection Molding and Composites
- Design for Die Casting
- Design for Forging, and
- Design for Finishing.

Using the appropriate and applicable DFM techniques will ensure that the component part is designed to ensure the lowest possible manufacturing cost. When designing parts that will be produced for many years and at up to thousands manufactured every day, it is highly prudent to ensure that the best design is done upfront in the development process. This will save untold dollars in making expensive changes once the product is in production.

Results

The first full week tear-down workshop in the USA was a huge success. The automotive supplier that hosted the workshop had read the Sato/Kaufman book and were familiar with the concepts in the book. However, by their own admission going through the actual workshop with Rains and Sato and actually putting to use the concepts with the experts, proved to be a significant benefit. Now they are able to continue this effort on their own, knowing that they have not only been taught by the best, but the person who actually invented and developed the methodology. The results were significant for the projects that were worked on during the workshop, but we feel that the knowledge and training that the people received so that they can be self-sufficient in the future is even more valuable.

When Jim Rains was working with a heating component company, he decided to propose to the company that they integrate Sato’s TD workshop, DFA as part of the Dynamic TD (DRM Associates process) and value engineering. The integrated workshop took two weeks. The two weeks were sep-
arated by one week. The final result of this workshop was just outstanding. Not only did the company make significant improvements to their current product, they developed a new product that did not exist in their product portfolio that would allow them to improve their competitive position in the market place and take business away from their competitors.

We wish that we could discuss these results in more detail, however, due to Confidentiality Agreements that is not possible.

Conclusion

Mr. Sato quotes that, “All in all, as developer of Japanese Tear-down approach, I am proud that our methodology is more widely utilized among Japanese industrial circles than in the US.” Now that we know that the above statement is true, the next question remains is what is the industrial western world going to do about it. All western world companies that have made progress in utilizing the techniques developed in Japan by Mr. Sato have found them to be beneficial and an important element of their product development strategy. It is not enough to only fully understand your products, including its design strengths and weaknesses, cost detail, performance, functional elements, and selling features. This same information must be known on the competition’s products as well. Following the Japanese tear-down methodology with integrity has certainly proven to be necessary in improving corporate profitability.

It must be said, that using this detailed tear-down methodology on any given product line, is not a one-time activity. The best benefits come after many years of comparing competitor’s products to our own. A detailed database of previous analyses will allow you to see design change trends in your competitor’s designs. You may possibly even develop the skills to predict your competitor’s design changes before they actually occur.

In addition, the integration of Design for Assembly into the Dynamic Tear-down element and using the tear-down and DFA information as part of the Information Phase of a structured value engineering activity will definitely offer superior profitable results.
Appendix

The list on the page 29 (see Figure 3) helps get the project team prepared for the products that they will be performing the tear-down benchmarking review on. The prep meeting with the team should be about 4 weeks prior to the workshop; or longer if time is needed to secure competitor’s products.

The list shown on page 30 (see Figure 4) is a list of tools and equipment that are normally needed to perform the tear-down workshop.

This final list (see Figure 5, at right) depicts the office supplies and display board materials required for the workshop.

References

1 Value Analysis Tear-down: A New Process for Product Development and Innovation by Yoshihiko Sato and J. Jerry Kaufman; Industrial Press Inc.; 2005; page 1
2 Ibid page 103
3 Website of DRM Associates; author Ken Crow; http://www.npd-solutions.com/dfmguidelines.html
4 Form developed by Ken Crow of DRM Associates

Author Information

James A. Rains, Jr., CVS-Life, FSAVE, PVM has been President of the Advanced Value Group, LLC (AVG) since 2000. AVG specializes in value engineering, tear-down analysis, target costing, Design for Assembly and synchronous process improvements in the factory or office environment. Before Jim launched AVG, he worked at General Motors. Jim has served on the SAVE International Board of Directors in several capacities, including President. Mr. Rains became a Certified Value Specialist in 1988 and is currently a Life - CVS. Jim has presented numerous papers and workshops around the globe. He was elected into the SAVE College of Fellows in 2002. He is a member of the Lawrence D. Miles Value Foundation Board of Directors, Executive Committee and Treasurer.

Yoshihiko Sato, CVS-Life, FSAVE is currently President, VPM Inc. and serves as an Associate Director for the Society for Japanese Value Engineering (SJVE). Upon graduation from Kanagawa Technical High School, he started building his brilliant VE ca-

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Figure 5. VA Tear-Down Office Supplies Check List

V A L U E  W O R L D
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